

Physiological Protection Against Chemical and Biological Agents

Jonathan W. Kaufman, Ph.D.
Naval Air Warfare Center Aircraft Division
Patuxent River, Maryland

Problem

Chemical/Biological Warfare

- Weapon of mass destruction (strategic)
- Incapacitate or kill enemy forces (tactical)
- Reduce operational effectiveness
- Deprive enemy access to territory, equipment
- Crop, farm animal destruction
- Terrorism

Goal

Developing convenient, reliable
individual protection against toxic
chemical and biological agents
targeting personnel

CW/BW Agent Physical Properties

Deployable Physical States

- Vapor
- Aerosols
 - Neat
 - Thickened
- Dry Powders
 - "dust"
 - microencapsulation

CW/BW Agent Physical Properties

- Thickening
 - Controls particle size by slowing evaporation and increasing resistance to shear forces
 - Reduces rates of droplet spread & surface penetration (esp. important for percutaneous transport)
 - Makes decontamination more difficult
- Dust/Microencapsulation
 - Enhance agent airway transport by carrier material
 - Reduces environmental degradation of agent

Jon - Include Definition/
Description of Neat? You've
Defined All Other States.

Factors affecting CW/BW agent effectiveness

- Atmospheric Conditions
- Agent Physiochemical Properties
- Biological Factors

Factors affecting CW/BW agent effectiveness

Atmospheric Conditions

- temperature
- humidity
- wind
- sunlight
- UV strength
- precipitation

Factors affecting CW/BW agent effectiveness

Agent Physiochemical Properties

- Chemical Composition
- Reactivity
- Concentration
- Water/Lipid Solubility
- Particulates
 - Aerodynamic Diameter
 - Size distribution
 - shape
 - surface area

Reactivity - could mean a few different things - might want to include a sub-bullet or two similar to 'particulates'

Chemical Agent Physical Properties

- **Nerve** [sarin (GB), soman (GD), V-agents] - liquid/thickened, highly volatile (exc. V-agents)
- **Blister** [mustard (H/HD), Lewisite (L)] - liquid/thickened/solid, generally volatile
- **Choking** [phosgene (CG)] - liquid, highly volatile
- **Blood** [hydrogen cyanide (AC)] - liquid, extremely volatile
- **Psychoactive** [2-quinuclidinyl benzilate (BZ)] - liquid, slight volatility

Factors affecting CW/BW agent effectiveness

Biological Properties

- Absorption Pathway
- Physiological State (age, weight, exposed surface area, etc.)
- Health
- Physiological neutralization
- Contact Time

Factors determining BW agent effectiveness

- Small aerosol dose produces infection/intoxication
- Infection or intoxication causes incapacitation or death
- Agent produced easily & cheaply in significant quantities
- Agent stable when dispersed
- Symptoms difficult to detect and treat
- Real-time detection unavailable

JON - MINOR POINT - FONT/POINT

SIZE SEEMS SMALLER THAN

TEXT ON OTHER CHARTS

Biological Agent Physical Properties

Potential Bacterial Agents

- Anthrax*
- Plague*
- Tularemia*
- Brucellosis*

* - Likely militarized agent posing significant threat

Biological Agent Physical Properties

Potential Viral Agents

- Smallpox*
- Venezuelan Equine Encephalitis (VEE)*
- Q fever*
- Ebola
- Marburg virus

* - Likely militarized agent posing significant threat

Biological Agent Physical Properties

Potential Biological Toxin Agents

- Botulinum*
- Ricin*
- Staphylococcal Enterotoxin B (SEB)*
- Aflatoxin
- Tricothecene

* - Likely militarized agent posing significant threat

Site of action, biological toxins

Toxins

- cholera - acts on intestines, incapac.
- Botulinum - inhibits ACh
- SEB - paralyzes smooth muscle, incapac at μg , kills >
- saxitoxin - nerve ion transp., paralyzing & kills
- tetrodotoxin - muscle ion transp., kills by respir. failure
- aflatoxin - hemorrhage, fatal
- ricin

} - Point Size?

BW dose-response relationship

	Effective human dose	Time to effect/effect
Bacteria		
Plague	~ 3,000 organisms	1-5 days/ lethal
Anthrax	> 8,000 spores	1-5 days/ lethal
Tularemia	10-100 organisms	1-10 days/ incapac.,
Viruses		
Smallpox	1-10 viral particles	6-12 days/ lethal
VEE	1-10 viral particles	2-5 days/ incapac.
Toxins		
Botulinum	0.0048 mg	< 1-2 days/ lethal
SEB	0.039 mg	1-6 hrs/ incapac.
Saxitoxin	<0.1 mg	minutes/ lethal

CONSIDER ADDING LINES -
MAKES THE GROUPING
MORE OBVIOUS

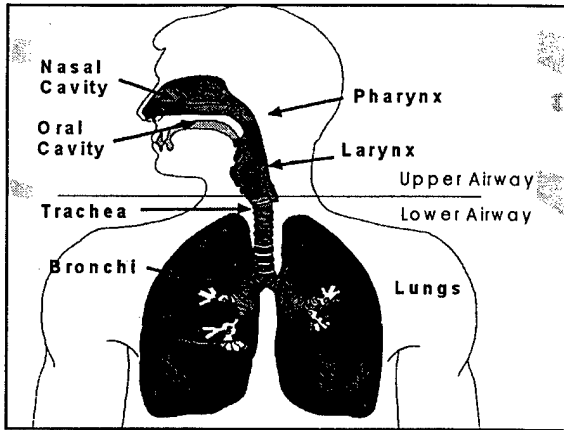
Physiological Pathways

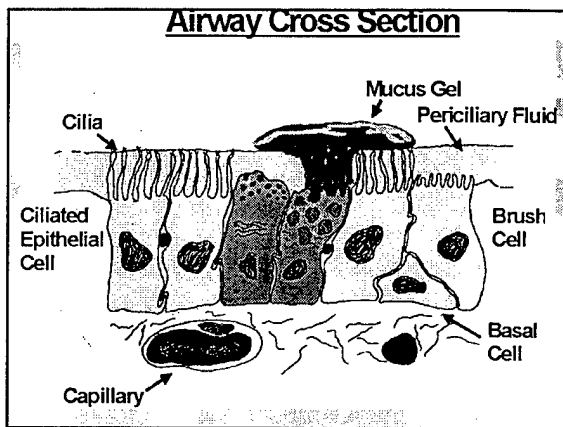
- **Respiratory Tract**
 - chemical agents
 - bacteria (*anthrax, plague*)
 - viruses (*VEE*)
 - Toxins
- **Percutaneous**
 - chemical agents
 - bacteria (*tularemia*)
 - viruses (*smallpox*)
- **Other pathways** (Ocular, Ingestion)

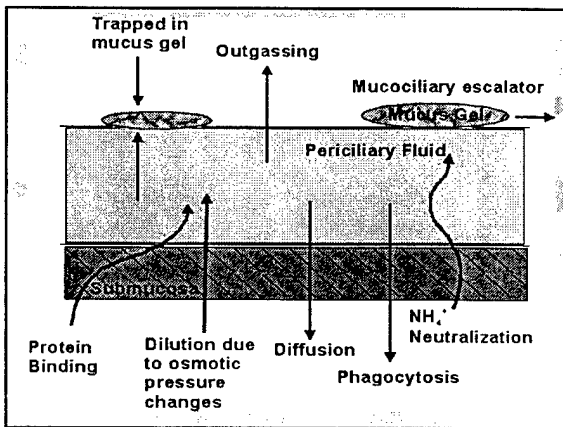
Physiological Pathways

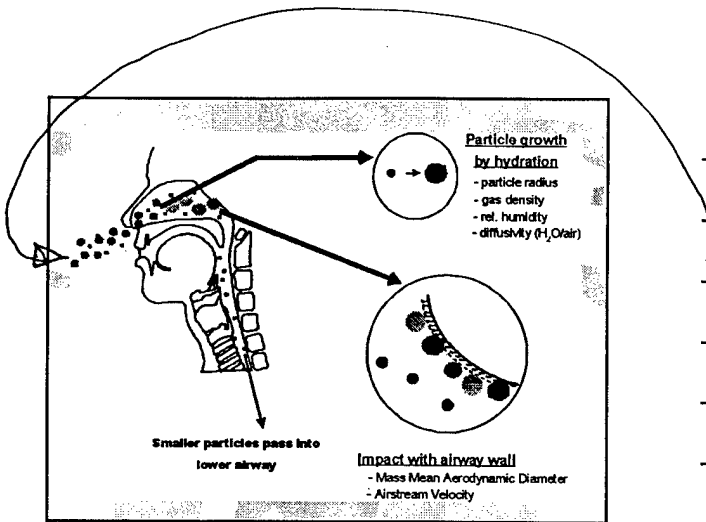
Physiological factors influencing airway deposition and absorption

- ♦ breathing frequency
- ♦ tidal volume
- ♦ minute ventilation
- ♦ mucociliary transport
- ♦ submucosal blood flow
- ♦ metabolism (NH_3 production)

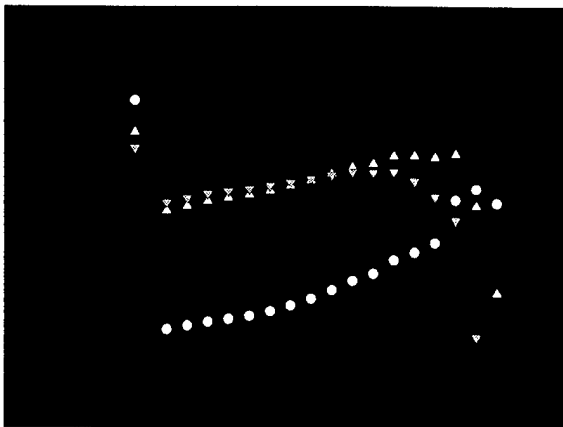
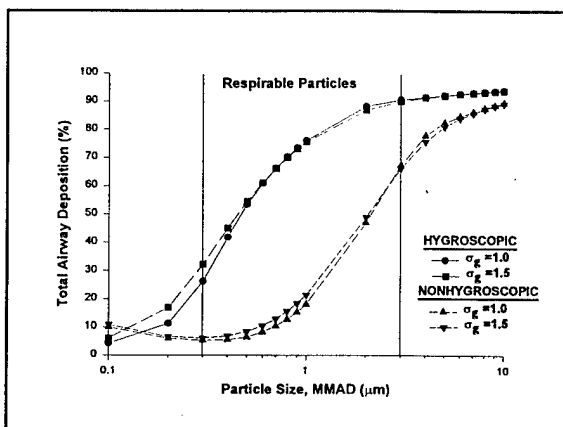








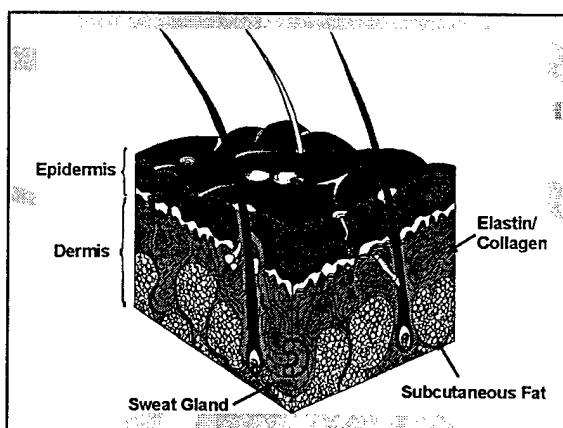
A44-CH00



Physiological Pathways

Physiological factors influencing percutaneous absorption

- Exposed surface area
- skin integrity (*open wounds, lesions*)
- skin thickness (*subcutaneous fat*)
- surface moisture (*sweat*)
- subdermal blood flow
- agent transport mechanisms (*diffusion, active transport, facilitated diffusion*)



Future Issues

- What new agents are being developed?
- What are potential new delivery methods?
- Can new agents or modified "classical" agents defeat protective measures?
(equipment, materials, detectors, medical treatments)
- What new protective techniques will work against burgeoning threat?

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE		2. REPORT TYPE Viewgraphs		3. DATES COVERED	
4. TITLE AND SUBTITLE Physiological Protection Against Chemical and Biological Agents				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Dr. Jonathan Kaufman				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Warfare Center Aircraft Division 22347 Cedar Point Road, Unit #6 Patuxent River, Maryland 20670-1161				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Air Systems Command 47123 Buse Road Unit IPT Patuxent River, Maryland 20670-1547				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dr. Jonathan Kaufman
Unclassified	Unclassified	Unclassified	Unclassified	9	19b. TELEPHONE NUMBER (include area code) (301) 342-8883

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18